TEN PROPOSITIONS
Emerging Airpower

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ABOUT SIX years ago, when Air Force Manual (AFM) 1-1, *Basic Aerospace Doctrine of the United States Air Force*, was being rewritten, Lt Gen Michael Dugan, deputy chief of staff for plans and operations, proposed an unusual idea. Doctrine manuals were fine, but he wanted something brief and succinct—something that encapsulated the essence of airpower. His ultimate goal: to produce a list of principles or rules of airpower so succinct they would fit on a wallet-sized card that airmen could carry in a pocket. My first reaction was one of skepticism. As a historian, I had been taught to eschew simple solutions, formulas, models, and similar gimmicks that attempted to deal with complex problems. Yet, as one observer phrased it, "The consistency of the principles of war indicates that despite the doubts expressed by military theoreticians concerning their validity, they satisfy a deep need in military thinking."[1] Such a "need" encompasses the psychological search for guidelines when in chaos, the tendency to apply scientific concepts of cause and effect to daily activities, and the desire for an understandable system of beliefs to use as an educational tool for young officers.

The general's proposal faded, but, in truth, it never left my mind. The more I thought about it, the more appealing it seemed. Truly good writing, in my view, should be short, swift, and to the point. As Mark Twain said, "If I'd had more time I would have written less." Capturing the essence of what airmen believe about airpower and putting it into a concise and understandable—but not simplistic—format was a challenge.

I encountered a catalyst when I was preparing a course on the history of airpower theory. Reading the works of the top theorists—Giulio Douhet, Hugh Trenchard, Billy Mitchell, John Sles
sor, the officers at the Air Corps Tactical School (ACTS), Alexander de Seversky, John Warden, and others—brought many similarities to light. Even though living in different times, different places, and different circumstances, these men had distilled certain principles, rules, precepts, and lessons that seemed timeless and overarching. Some of these had been demonstrated in war; others were mere predictions. After 75 years, however, I think there have been enough examples of airpower employment and misemployment to derive some propositions—*principles* would be too grand a term—from the theories. First, however, let me briefly describe some of airpower's unique characteristics—some strengths and some weaknesses—from which these propositions derive.

Even before the airplane was invented, writers sensed that themedium of the air possessed intrinsic qualities that could be exploited for war, and it is quite amazing how quickly after the Wright brothers first flew in 1903 that military men were positing the use of the airplane as a weapon. During the war between Italy and Turkey in Libya in 1911, airplanes were used for the first time in combat. Virtually all of the traditional air missions were employed: observation, air defense, air superiority, transport, ground attack, even bombing.[2] The world war that erupted a few years later saw all these air missions refined. By the end of the Great War, both air and surface officers were in general agreement about the unique strengths and weaknesses of airplanes.

Airpower's attributes include range (even the flimsy planes of 1918 could fly several hundred miles), speed (over 100 miles per hour [mph]), elevation (the ability to fly over hills, rivers, and forests that impede surface forces), lethality (concentrated firepower could be directed at specific points on and behind the battle area), and flexibility (a combination of other attributes that allowed airplanes to be used quickly, in many ways and places). The limitations of airpower were also apparent early on. Unlike surface forces, airplanes could not live in their medium and had to land in order to refuel and rearm. This restriction, in turn, meant aircraft were ephemeral: air strikes lasted but a few

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minutes and therefore lacked persistence. Although airplanes could indeed fly over obstacles, they were limited by bad weather and the night. In addition, as was true of surface forces, political restrictions could determine where, when, and for what purpose aircraft flew. Finally, aircraft could not occupy or hold ground. Even 75 years later, these attributes and limitations generally hold true, although some have clearly been nibbled away at the edges.

It is significant to point out here that, over the years, both air and surface proponents have cited these various characteristics—positive and negative—to justify their own views on how aircraft should be used in war. Airmen magnified the importance of the attributes but minimized the limitations. They wished to establish a separate service that would not be subordinate to surface commanders. Ground and sea advocates, however, noted the limitations inherent in airplanes but downplayed the positive aspects. They wished to maintain dominance of the new air arm. This political debate over whether airpower was revolutionary or evolutionary and, therefore, whether it should or should not be a separate service occupied decades of heated argument and caused needless animosity.

Today, all major countries have an air force as a separate service. More importantly, however, people are now aware that separateness does not equal singularity. Wars are fought in many ways, with many weapons. Seldom is one service used to wage a campaign or war, although one service may dominate such conflicts. The nature of the enemy and the war, the objectives to be achieved, and the price people are willing to pay determine what military instruments will be employed and in what proportion. My purpose in this article is to identify and discuss 10 propositions regarding airpower (see sidebar) in the hope that this endeavor will better inform those people who employ military power and allow them to achieve objectives established by the country's leaders.

Ten Propositions Regarding Airpower

1. Whoever controls the air generally controls the surface.

2. Airpower is an inherently strategic force.

3. Airpower is primarily an offensive weapon.

4. In essence, airpower is targeting; targeting is intelligence; and intelligence is analyzing the effects of air operations.

5. Airpower produces physical and psychological shock by dominating the fourth dimension--time.

6. Airpower can simultaneously conduct parallel operations at all levels of war.

7. Precision air weapons have redefined the meaning of mass.

8. Airpower's unique characteristics require centralized control by airmen.

9. Technology and airpower are integrally and synergistically related.

10. Airpower includes not only military assets, but aerospace industry and commerical aviation.

1. Whoever Controls the Air Generally Controls the Surface

If we lose the war in the air, we lose the war, and we lose it quickly.

—Field Marshal Bernard Montgomery

Some people refer to this concept as command of the air; others call it air superiority. But the point is clear: the first mission of an air force is to defeat or neutralize the enemy air force so that friendly operations on land, at sea, and in the air can proceed unhindered, while at the same time one's own vital centers and military forces remain safe from air attack. Virtually all airpower theorists subscribe to this proposition. Douhet, for example, stated simply that "to have command of the air is to have victory."[3] In a similar vein, John Warden wrote, "Since the German attack on Poland in 1939, no country has won a war in the face of enemy air superiority. . . . Conversely, no state has lost a war while it maintained air superiority."[4] Whether such a statement is true in unconventional warfare is debatable, but the armies of Germany, Japan, Egypt, and Iraq would certainly agree that conventional ground operations are difficult—if not impossible—when the enemy controls the air.

This emphasis on gaining air superiority often troubles ground commanders, who tend to equate proximity with security. Rather than have aircraft attack airfields or aircraft factories in the quest for air superiority, they prefer to have them close by and on call in the event enemy planes appear. This desire is understandable but misguided because it would be unwise to tether airpower to a static, defensive role. An aggressive doctrine has been very effective for the United States: American troops have not had to fight without air superiority since 1942; 1953 was the last time an

American ground soldier was killed by air attack; and our Army has never had to fire a surface-to-air missile at enemy aircraft—because they have never been allowed to get that close.[5] In actuality, our Army's doctrine *assumes* friendly air superiority and sees its achievement as one of airpower's biggest contributions to land operations.

This need for air cover also extends to maritime operations. As early as the First World War, naval aviators such as John Towers saw the need for aircraft carriers to ensure air superiority over the fleet. For many years, surface admirals rejected this view, but Pearl Harbor and the sinking of the British capital ships *Prince of Wales* and *Repulse* by Japanese land-based aircraft in 1941 soon made it clear that ships required air cover to operate effectively. Aircraft carriers provided the mobile air bases for the planes that would help to ensure air superiority over the fleet, while at the same time increasing the ability to project power ashore.[6] The armadas that conquered the Central Pacific in World War II were based on aircraft carriers—not battleships—and the US Navy's force structure has reflected this emphasis ever since.

The clear implication in the writings of the air theorists is that gaining air superiority is so important that it might bring victory (i.e., air superiority could be an end in itself). But two problems attend this construct. First, air superiority is valuable only if the political will is available to exploit it. United Nations (UN) aircraft can easily dominate the skies over Bosnia, for example, but how can that air superiority be exploited? If intransigent opponents do not believe that air strikes against their industry or military forces will follow, then control of the air becomes meaningless. Second, achieving air superiority reintroduces the concept of the decisive counterforce battle. Just as an army that invades another country and deliberately bypasses the enemy army while marching on the interior risks the occupation of its own country or the severing of its supply lines, so too an air force that goes straight for the heart of a nation while ignoring the enemy air force courts catastrophe. Consequently, if the fate of nations hinges on the campaign for command of the air, then presumably a belligerent will focus his efforts and resources in that area. If that occurs, the air battle can be just as prolonged, deadly, and subject to the grinding effects of attrition as any land war. This happened in World War II. Airpower did not eliminate the trench carnage of that war; it just moved it to 20,000 feet. In reality, the attainment of air superiority has not yet brought a country to its knees. Therefore, the proposition remains that air superiority is a necessary but insufficient factor in victory. It is the essential first step.

2. Airpower Is an Inherently Strategic Force

Airpower has become predominant, both as a deterrent to war, and—in the eventuality of war—as the devastating force to destroy an enemy's potential and fatally undermine his will to wage war.

—Gen Omar Bradley

War and peace are decided, organized, planned, supplied, and commanded at the strategic level of war. Political and military leaders located in major cities direct the efforts of their industry, natural resources, and populations to raise and equip military forces. These "vital centers" of a country are generally located well behind the borders and are protected by armies and defensive fortifications. Thus, before the invention of the airplane, a nation at war generally hurled its armies against those of an enemy in order to break through to the more vulnerable interior. Some people still think this way, as exemplified by a noted military historian who recently wrote, "According to Clausewitz and common sense, an army in wartime succeeds by defeating the enemy army. Destroying the ability of the opponent's uniformed forces to function effectively eliminates what stands in the way of military victory."[7] Sometimes a country was fortunate and was able to annihilate its opponent's army, as Napoléon did at Austerlitz and in the battles of Jena and Auerstadt; such success could bring quick capitulation. But more often, battles were bloody and indecisive; wars were exercises in attrition or exhaustion. As wars became more total, armed forces larger, and societies more industrialized, the dream of decisiveness usually became an unattainable chimera. Armies became tactical implements that ground away at the enemy army, hoping that an accumulation of battlefield victories would position them for decisive, strategic operations.[8]

To some extent, navies are also condemned to fight at the tactical level of war. After one has gained command of the sea, a fleet can then bombard fortresses near shore, enforce a blockade, or conduct amphibious operations. In the first case, however, the results are limited by the range of the ships' guns; in the second, the enemy feels the results only indirectly and over time. Certainly, a blockade can deprive a belligerent of items needed to sustain the war effort; however, the blockaded party can substitute and redistribute its resources to compensate for what has been denied. In short, indirect economic warfare takes much time; indeed, only rarely has a blockade brought a country to its knees.[9] In the last instance, amphibious operations are generally only a prelude to sustained land opera-

tions, but this action merely takes us back to the cycle of army versus army.

Airpower changed things by compressing the line between the strategic and tactical levels. Aircraft can routinely conductoperations that achieve strategic-level effects. To a great extent, airplanes obviate the need to confront terrain or the environment because of their ability to fly over armies, fleets, and geographic obstacles and strike directly at a country's key centers. This capability offers alternatives to both bloody and prolonged ground battles and deadly naval blockades. In truth, although early airpower theorists often spoke of the potential of this concept, it was largely a dream for many decades. Airpower did not remove the need for a land campaign in Europe during World War II, and although an invasion of Japan proper was unnecessary, the evidence was not clear-cut—it took four years and the combined operations of all the services to set the stage for the final and decisive air phase. Korea and Vietnam proved to many people that airpower was not an effective strategic weapon, although some would maintain that we never gave it a chance to prove itself.[10] Operation Desert Storm, on the other hand, came close to realizing the claims of the early theorists. Whether that event was the fulfillment of prophecy or an aberration remains to be seen.

If the former, then Desert Storm confirms the premise that the goal of air commanders is to maximize their intrinsic advantage by operating at the strategic level of war while forcing the enemy to fight at the tactical level. Coalition airpower achieved this type of mismatch in the Gulf when, for example, it deprived Iraqi air defenses of centralized control, causing them to devolve into ineffectual tactical operations, devoid of strategic significance. Although one can also employ airpower at the operational and tactical levels, one should consider such instances closely to ensure that the effect intended is worth the candle. In essence, air war requires broad, strategic thinking. The air commander must view war in totality—not in a sequential or circumscribed fashion.

Finally, one must note that airpower has great strategic capabilities as a nonlethal force. In an interesting observation, John Warden noted that, basically, airpower delivers strategic information: some of it is "negative" (such as bombs) and some is "positive" (such as food). For example, the Berlin airlift of 1948–49 was perhaps the greatest Western victory of the cold war prior to the fall of the Berlin Wall itself. Yet, the airlift was a demonstration of airpower's peaceful application. After the Soviets shut off all land routes into West Berlin, airlifters supplied all the food, medicine, coal, and other essentials needed by the population over the next 10 months. The result of the airlift was enormous: the city remained free. This was a strategic victory of the first order, not in the least diminished because airpower achieved it without firing a shot. The evolving world calls for a greater reliance on airlift, both for forceprojection and humanitarian assistance. Advances in technology similarly emphasize the importance of space-based air assets such as communications and reconnaissance satellites that ensure nearly instantaneous command and control (C^2) of military forces, highly accurate location reporting, intelligence gathering, and treaty verification. Clearly, the importance of strategic airpower to our national security structure is growing—not decreasing.

3. Airpower Is Primarily an Offensive Weapon

War, once declared, must be waged offensively, aggressively. The enemy must not be fended off, but smitten down.

—Adm Alfred Thayer Mahan

Axiomatic to surface theorists is the idea that defense is the stronger form of war. That is, a country or army in a weak position will generally assume the defensive because it offers certain advantages. A defender can dig in, build fortifications, and operate on interior lines in friendly, familiar terrain. An attacker, therefore, has to assault this well-prepared enemy, usually by exposing himself to enemy fire. Moreover, the deeper one advances into enemy territory, the farther he is from his sources of supply. These innate strengths led Sun-Tzu to comment that "being invincible lies with defense; the vulnerability of the enemy comes with the attack."[11] The standard rule was that it took a three-to-one superiority at the point of attack to overcome a foe in prepared positions. As a result, one assaulted the enemy where he was not expecting it, thus ensuring superior numbers at the crucial point. One must understand, however, that the same theorists who believe the defense is the stronger form of war also admit that one seldom wins wars by remaining on the defensive; offensive action will eventually be essential. Thus, a defender must husband his resources in preparation for going over to the attack at a favorable opportunity.

Airpower does not fit this formulation. The immensity and tracklessness of the sky allow one to strike from any direction, whereas armies generally move over well-defined routes. In
terception is the key issue here; certainly, radar will be watchful for an air attacker, but terrain masking, electronic measures, careful routing, and stealth technology make it extremely difficult to anticipate and pre-

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pare for an air assault. H. G. Wells commented in 1908 that there were no highways in the sky—all roads led everywhere.[12] He was, and still is, correct. Because there are no flanks or fronts in the sky, an air defender has little chance of building fortifications there or of channeling an enemy into a predictable path so his defenses can be more effective. Stoppingan air attack completely is virtually impossible—some planes will get through. Even when Eighth Air Force bombers suffered "disastrous" losses in strikes against Schweinfurt in fall 1943, over 85 percent of the bombers penetrated enemy defenses and struck their targets. Surface forces, on the other hand, generally either break through or are repelled—an all-or-nothing proposition.

Moreover, in order to defend all his vital areas, an air defender must spread his squadrons widely, and each point protected must have sufficient strength to drive back an attacker.[13] Unlike the surface defender, the air defender has no implicit advantage—passive defense is impractical. Whereas the attacker can strike virtually anything, the defender is limited to striking the attacker—an inefficient situation. In addition, an effective defense requires a well-organized, responsive, and survivable C^2 network; the offense does not. Even if such a defensive system is in place, however, dispersion in an attempt to cover all of a country's vital areas may grant de facto local air superiority to an attacker. In short, in air warfare, the defender is stripped of his innate three-to-one superiority, and an air defender theoretically needs more forces than the attacker—the precise opposite of the situation on the ground.[14] This line of reasoning led Douhet and others to term the airplane the offensive weapon par excellence. If that notion is true, then interesting conclusions follow.

First, one reaps a reward by assuming the offensive. To wait in the air is to risk defeat; therefore, an overwhelming air strike offers great temptation. When such attacks are carried out, they can have devastating effects—as at Pearl Harbor or in the Arab-Israeli War of 1967 or Desert Storm. At the very least, the need for maintaining the initiative necessitates a sufficient air force in-being that is ready for immediate and decisive action upon the outbreak of hostilities. In air war, one cannot afford a mobilization that takes weeks or months—the conflict may be over before it can take effect.

Similarly, Sun-Tzu's dictum that a wise commander defeats the enemy's strategy is inappropriate in air war because it assumes one will wait to see what that strategy is and then move to counteract it. Not only is this a risky business (one can easily guess wrong about the opponent's strategy and therefore counter the wrong move), but it once again surrenders the initiative to the enemy.[15] Finally, the concept of offensive airpower obviates the need for a tactical reserve. Land forces establish a reserve whose mission is to stand ready either to exploit success or reinforce a threatened point. Both of these scenarios imply a reactive and defensive posture. Air battles, on the other hand, occur and end so quicklythat except in very limited circumstances, air commanders should avoid holding a reserve; instead, they should commit all available aircraft to combat operations.[16] In truth, this issue is ambivalent enough to warrant further study. Clearly, a reserve as meant in land operations is not applicable to air war. But could one argue that aircraft based in a different country hundreds of miles distant, yet only minutes away from the battle space, actually constitute a "tactical reserve"?[17]

In summary, the speed, range, and flexibility of airpower grant it ubiquity, which in turn imbues it with an offensive capability. Because one generally attains success in war while on the offensive, the adage "the best defense is a good offense" is almost always true in air war.

4. In Essence, Airpower Is Targeting; Targeting Is Intelligence; and Intelligence Is Analyzing the Effects of Air Operations

How can any man say what he should do himself if he is ignorant of what his adversary is about?

—Baron Antoine-Henri Jomini

Airpower—both lethal and nonlethal—can be directed against almost anything. The Gulf War showed that digging deeply and using tons of steel and concrete will not guarantee protection from precision penetration bombs. The hardened bunkers of the Iraqi air force were designed to withstand a nuclear attack, but they could not survive a perfectly placed high-explosive bomb. However, being able to strike anything does not mean that one should strike everything. Selecting objectives to strike or influence is the essence of air strategy. Virtually all air theorists recognized this point; unfortunately, they were frustratingly vague on the subject.

Douhet, for example, left it to the genius of the air commander to determine an enemy's "vital centers."[18] He did, however, single out popular will as being of first importance. He predicted that if the people were made to feel the harshness of war—through bombing urban areas with high explosives, gas, and incendiaries—they would rise up and demand that their government make peace. Other theorists had different candi-

dates for priority targets. ACTS devised a doctrine concentrating on enemy industry. Their "industrial web" theory characterized a nation's structure as a network of connected and interdependent systems; as with a house of cards, if just the right piece were removed, the entire edifice would collapse and with it a country's capacity to wage war.[19] The Royal Air Force's (RAF) Jack Slessor emphasized the vulnerabilityof a country's transportation structure, advocating the interdiction of troops and supplies as the best method of achieving objectives.[20] John Warden stressed leadership. Since a country's leaders make decisions regarding peace and war, one should focus all air efforts on the will of those leaders to induce them to make peace.[21] The early writings (pre-1925) of Billy Mitchell saw the enemy army as the primary target of strategic airpower.[22] Thus, all the classic air theorists have had similar notions regarding centers of gravity, but they diverge on singling out the most important one. Indeed, a skeptic could argue that a history of air strategy is a history of the search for the single, perfect target.[23] Nonetheless, this basic framework for determining air strategy was a useful first step—but only a first step.

Airpower's ability to affect targets has always exceeded its ability to identify them. The Gulf War demonstrated that if one does not know that a target exists, airpower may be ineffective. For example, although coalition aircraft destroyed most of the known nuclear, biological, and chemical research facilities in Iraq, far more were unknown and not discovered until UN inspectors roamed the country after the war.[24] For airmen to claim that this was a failure of intelligence—not of airpower—is an evasion because the two are integrally intertwined and have always been so. Intelligence is essential to targeting; moreover, one requires intelligence specifically geared to air war. Military information-gathering agencies have existed for centuries, but their products were of a tactical nature: How many troops does the enemy possess? Where are they located? What is their route of march? What is the rate of fire of their latest weapons?

Although such tactical information was also necessary for airmen to fight the tactical air battle, strategic air warfare demanded more: What is the structure of an enemy's society and industry? Where are the steel mills and power plants? How do civilian and military leaders communicate with their subordinates? Where are the major rail yards? How far advanced is the chemical warfare program? Who are the key leaders in society, and what are their power bases? These types of questions, essential to an air planner, had seldom been asked before the advent of the airplane because they did not need to be.[25] Two analysts even argue that intelligence has become "a strategic resource that may prove as valuable and influential in the post-industrial era as capital and labor have been in the industrial age."[26] In this formulation, the key to all conflict is intelligence.

The third step, no less important than the first two, is analyzing the effects of air attacks. One aspect of this problem is termed bomb damage assessment (BDA), but it is only oneaspect—with largely tactical implications. The simplest way of determining BDA is through postattack reconnaissance; however, the advent of precision munitions often renders this procedure inadequate. During the Gulf War, for example, coalition aircraft struck an Iraqi intelligence headquarters building. BDA reported that the sortie was 25 percent effective because one-quarter of the building was destroyed. Yet, the wing of the building hit by the bomb was precisely where the actual target was located. In reality, the sortie was totally effective. The BDA process used a measurement technique appropriate to a time when precision was unobtainable, so obliteration was necessary.[27] In short, BDA is as much an art as a science, and it is often difficult to determine the effects of a precision air strike.

The assessment problem at the strategic level is far more complex. Present standards used to measure the effectiveness of strategic air strikes are insufficient. In some instances, such as assessing damage to an electrical power network, the relationship between destruction and effectiveness is not linear. For example, during Desert Storm, Iraq shut down some of its power plants even though they had not been struck, apparently hoping that this action would shield them from attack. Because the coalition's intent was to turn off the power—not destroy it—the threat of attack was as effective as the attack itself. Thus, a small number of bombs produced an enormous power loss.[28] Unfortunately, although one can ascertain that a power plant is not generating electricity, judging how that fact will affect the performance of an air defense network (which may be the true goal of the attack) is a far more difficult task.

This assessment problem has haunted air planners for decades. Some people still have heated debates over the effectiveness of strategic bombing during World War II. Were the selected targets the correct ones? Was there a better way to have fought the air war? Surprisingly, this question has not been answered by computer war games, which are unable to assess the strategic effects of air attack. Because of the visual impressiveness of these games, however, participants are mistakenly led to believe they are engaged in a scientific exercise. The challenge for airmen is to devise methods of analyzing the relationships between complex systems within a country, determining how best

to disrupt them, and then measuring the cascading effect of a system's failure throughout an economy.[29]

We are a quantitative society with a need to count and measure things, especially our effectiveness. The military has a proclivity for body counts, tonnage figures, sortie rates, percentage of hits on target, and so forth. Such mechanisms areespecially prevalent in air war because there is no clear-cut way of determining progress. Surface forces can trace lines on a map, but airmen must count sorties and analyze sometimes obscure and conflicting intelligence data. The real air assessment usually comes after the war. How do we break out of this American penchant for "Nintendo warfare"? Because airpower is a strategic force, we must better understand, measure, and predict its effectiveness at that level of war. For too long airmen have relied upon a "faith-based" targeting philosophy that emphasizes logic and common sense rather than empirical evidence.

5. Airpower Produces Physical and Psychological Shock by Dominating the Fourth Dimension—Time

How true it is that in all military operations time is everything.

-Duke of Wellington

When discussing the reasons for his success at Austerlitz, Napoléon noted that he, unlike his opponents, understood the value of a minute. He understood the importance of time. In truth, Napoléon was referring more to timing. Synchronizing the actions of multiple units so as to maximize their effect is vital—this is timing. Equally important, however, is thinking of time as duration. Commanders must consider how long it will take to move their units into position and then to actually employ them. More importantly, they must realize that when force is applied rapidly, it has both physical and psychological consequences that dissipate when it is employed gradually. Airpower is the most effective manager of time in modern war because of its ability to telescope events. It produces shock.

Although separating the physical and psychological components of shock is difficult, the two are decidedly different. Physical shock results when force collides with an object. It includes an element of overwhelming power; it is irresistible. Prior to this century, heavy cavalry generally produced shock, although at times heavily armed infantry deployed in column could also achieve this effect. Indeed, when handled properly, a charge of mounted troops produced enormous shock, sometimes sweeping away the enemy force, as at Arbela and Rossbach. Such was not always the case, however. Firepower could at times repel such a cavalry charge, as at Crécy and Waterloo. Nonetheless, shock effect on the battlefield is still important, although today it is generally provided by armored forces. Airpower can similarly produce physical shock because of the enormous amount of firepower it can deliver in a concentrated area. The impact of a B-52 loaded with 19 tons of high-explosivebombs is legendary, and even one F-15E can drop four tons of bombs on a spot with a footprint no greater than a good-sized house.

More importantly, airpower can produce psychological effects. At its most fundamental level, war is psychological. It may be that the best way to increase psychological shock is to increase physical shock, but one must be careful not to equate destruction with effectiveness. Rather, a commander should capitalize on airpower's speed and ubiquity—its ability to increase dramatically the tempo of combat operations. One realizes the importance of these characteristics upon remembering that even the most energetic army is constrained by its speed of march. In studying thousands of campaigns over several centuries, one US Army researcher discovered that mechanized and armored forces stand still between 90 and 99 percent of the time. While heavily engaged with the enemy, they generally advance at the rate of approximately three miles per day—about the same as for infantry. There have been exceptions over the years, of course, but the study concludes that rates of ground advance have not appreciably changed over the past four centuries, despite the advent of the internal-combustion engine and the changes it has brought to the battlefield.[30]

Airpower increases speed of movement by orders of magnitude. Aircraft routinely travel several hundred miles into enemy territory at speeds in excess of 700 mph. Such mobility means that a commander can move so rapidly in so many different directions, regardless of surface obstacles, that a defender is at a severe disadvantage. This conquest of time by airpower provides surprise, which in turn affects the mind, causing confusion and disorientation. John Boyd's entire theory of the observe-orient-decide-act (OODA) loop is based on the premise that telescoping time—arriving at decisions or locations rapidly—is the decisive element in war because of the enormous psychological strain it places on an enemy.[31] In addition, speed and surprise can sometimes substitute for mass: if an enemy is unprepared physically or mentally for an attack, then force—rapidly and unexpectedly applied—can overwhelm him (e.g., France in 1940 and Russia in 1941). Moreover, surprise and speed can help reduce casual-

ties because the attackers are less exposed to enemy fire. The fact that speed equaled survival is one reason jet aircraft quickly replaced piston-driven aircraft for most tactical air missions in the world's air forces.

Nuclear weapons offer the most compelling example of how airpower produces psychological shock. People have not really increased the destructive power of their weapons in centuries. The Romans destroyed Carthage totally, razing its buildings, killing its inhabitants, and sowing its soil with salt so nothing wouldgrow. The destruction at Hiroshima and Nagasaki caused by blast pressure and radiation had similar results. The difference between these events is that several Roman legions needed over two decades to cause such destruction, while a single B-29 needed only two seconds. It was this instantaneous destruction—this conquest of time, not of matter—that so affected the will of the Japanese people and the world in general. Indeed, it still does.

This point leads to an important insight regarding the effectiveness of airpower in low-intensity conflicts. Because guerrilla war is protracted war, by its very nature it is ill suited for airpower, denying it the ability to achieve decision quickly.[32] Campaigns like Rolling Thunder during the Vietnam War indicate that airpower is particularly ineffective when denied the opportunity to telescope time. In these instances, the limitations of airpower are magnified. Indeed, when robbed of the dimension of time, the psychological impact of airpower may be virtually negative.

6. Airpower Can Simultaneously Conduct Parallel Operations at All Levels of War

Whereas to shift the weight of effort on the ground from one point to another takes time, the flexibility inherent in Air Forces permits them without change of base to be switched from one objective to another in the theater of operations.

—Field Marshal Bernard Montgomery

The size of an army is usually determined by the size of the enemy's army (or that of the coalition arrayed against him), because the goal of the commander is to win the counterforce battle. Once that goal is achieved—quite possibly after a long time and much expense—the army can be used for such things as occupation and administrative duties. But that is not its main purpose; in any event, police or other paramilitary forces can effectively conduct such tasks. On the other hand, the size of an air force is not so dependent on the size of the enemy air force because fighting the air battle is only one of the many missions that airpower can conduct. More importantly, these other missions—such as strategic attack against centers of gravity, interdiction operations, or close air support (CAS) of ground troops in combat—are of potentially greater significance and can be conducted contemporaneously with the air superiority campaign.

Parallel operations occur when different campaigns, against different targets and at different levels of war, are conductedsimultaneously. Unlike surface forces that must generally fight sequentially and win the tactical battle before they can move on to operational or strategic objectives, air forces can fight separate campaigns at different levels of war. While carrying out the strategic mission of striking a country's armaments industry, for example, airpower is able to conduct an operational-level campaign to disrupt an enemy's transportation and supply system. Meanwhile, an air force may also be attacking an opponent's fielded forces at the tactical level.

This is precisely what occurred in Desert Storm. While F-117s, F-15s, F-111s, and Tornados struck Iraqi nuclear research facilities, oil refineries, and airfields, F/A-18s, F-16s, and Jaguars bombed rail yards and bridges in southern Iraq to reduce the flow of troops and supplies to the Iraqi army. At the same time, A-10s, AV-8s, and helicopters flew thousands of sorties against Iraqi troops and equipment in Kuwait. In sum, although one never refers to a tactical and strategic army or navy, one does talk of tactical and strategic air forces. It is of great significance that one can do so—a fact that acknowledges airpower's flexibility.

Similarly, airpower can concurrently conduct different types of air campaigns at the same level of war, such as an air superiority campaign and a strategic bombing campaign. Indeed, it may even implement a third or fourth separate strategic campaign, as was the case during World War II when Allied airpower bombed German industry and contested the Luftwaffe for air superiority over Europe, while simultaneously winning the Battle of the Atlantic against German submarines and choking off the reinforce
ments to Rommel's troops in North Africa.

Finally, and perhaps most importantly, airpower's speed and range allow it to strike targets across the entire depth and breadth of an enemy country. Aircraft do not have to disengage from one battle in order to move to another—an extremely risky and complicated maneuver for land forces. Having disengaged, aircraft do not have to traverse muddy roads, cross swollen rivers, or redirect supply lines in order to fight somewhere else. The Israeli Air Force provided an excellent example of this ability in the Yom Kippur

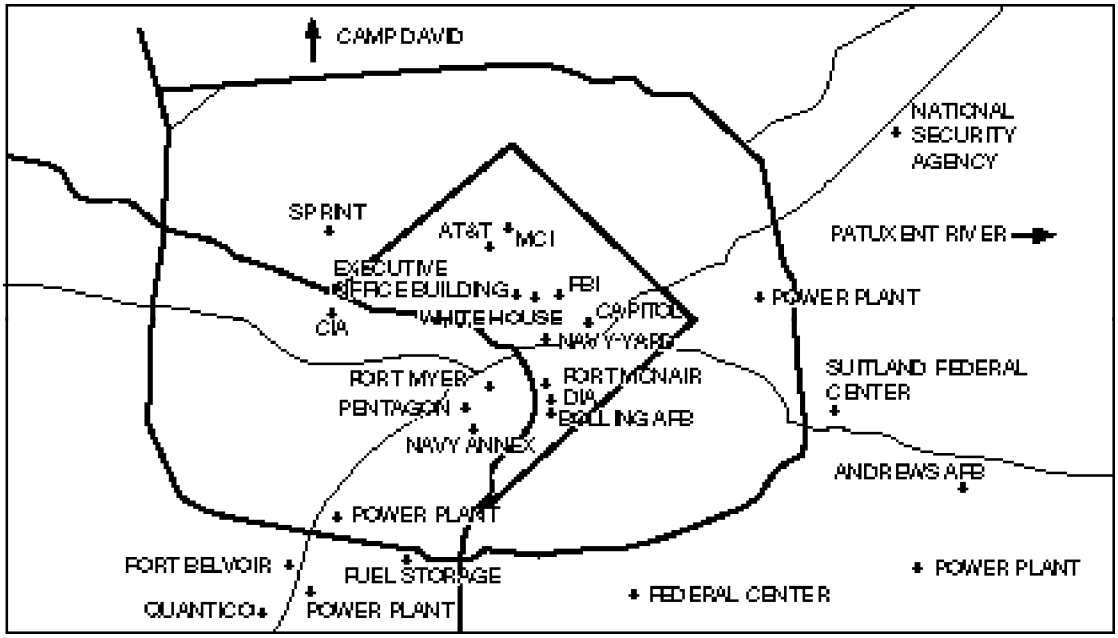

Figure 1. Hypothetical Parallel Attacks against Washington D.C.

War of 1973. The Israelis constantly shifted airpower from the Sinai front to the Golan Heights front and from interdiction to CAS. They were able to make these shifts on a daily basis over a period of several weeks.

Such parallel operations can also have parallel effects, presenting an enemy with multiple crises that occur so quickly he cannot respond effectively to any of them. The most devastating demonstration of this phenomenon occurred during the first two daysof the Gulf War, when hundreds of coalition aircraft hit, among other targets, the Iraqi air defense system, electric power plants, nuclear research facilities, military headquarters, telecommunications towers, command bunkers, intelligence agencies, and a presidential palace. These attacks occurred so quickly and so powerfully against several of Iraq's centers of gravity that to a great extent the country was immobilized and the war decided in those first few hours. The Iraqi leadership found it extremely difficult to move troops and supplies, give orders, receive reports from the field, communicate with the people, operate radar sites, or plan and organize an effective defense—much less contemplate an offensive counterattack. Although some people questioned the worthiness of Iraq as an opponent, figure 1 demonstrates how similar parallel attacks would have looked against Washington, D.C. Could we have maintained our balance in the face of such an onslaught?

Bearing in mind the fact that the coalition simultaneously carried out air operations against Iraqi forces in Kuwait, one can appreciate the impact that parallel operations can have on an enemy. Such an effect represents the "brain warfare" envisioned by J. F. C. Fuller,[33] only at the strategic rather than the tactical or operational levels of war. Military commanders have long sought to paralyze an enemy rather than fight him—to sever his spinal column (the command structure) instead of grapple in hand-to-hand combat. Parallel air operations now offer this opportunity. Flexibility, a key attribute of airpower, is never more clearly illustrated than in the conduct of parallel operations.

7. Precision Air Weapons Have Redefined the Meaning of Mass

Of what use is decisive victory in battle if we bleed to death as a result of it?

—Sir Winston Churchill

Mass has long been considered one of the principles of war. In order to break through an enemy defense, one had to concentrate force and firepower at a particular point. As firearms became more lethal at greater ranges, beginning in the midnineteenth century, defensive fortifications grew in importance. Defenses became so strong that it took increasingly greater firepower and mass to break through them.[34] Consequently,

commanders were warned not to piecemeal or disperse their forces: attempting to be strong everywhere meant they would be strong nowhere. Mass dominated land warfare, and planners focused on how to improve means of transportation and communication to ensure that mass was availableat the right place and time—before the enemy was aware of it. F. W. Lanchester's "N-squared law," which postulated that as quantitative superiority increased for one side, its loss rate correspondingly decreased by the square root, lent a modicum of scientific credence to this belief in mass.[35]

This principle also seemed to hold true for air war. Early operations of the Eighth Air Force in World War II resulted in high loss rates but had only a slight impact on the German war machine. The argument of Gen Ira Eaker, the Eighth's commander, was that his forces were not large enough. In order to ensure an effective strike yet at the same time provide defensive protection, bomber formations had to include at least 300 aircraft.[36] That figure proved low, however. German defenses were so formidable before the arrival of American escort planes that it took extremely large formations to ensure low casualty rates for the bombers—seemingly verifying Lanchester's "law" in practice.

Moreover, bombing accuracy was far less than expected, due partly to German defenses and deception and partly to abysmal weather. As a consequence, to destroy a target the size of a small house, one needed a force of 4,500 heavy bombers carrying a total of 9,000 tons of bombs.[37] Unfortunately, this process took time to neutralize a major system within a country. Taking down a single oil refinery required hundreds of bombers, but then the strike force would have to move to another target on the next mission.

Because Allied aircraft had to hit hundreds of targets, each requiring a massive strike, the Germans were able to rebuild their facilities between attacks. In other words, the absence of precision forced airpower into a battle of attrition that relied on accumulative effects, essentially driving airpower down to the tactical level.

An outstanding example of this situation in World War II concerns Germany's Leuna oil refinery, an important facility protected by extremely powerful antiaircraft gun defenses as well as smoke-generating machines to hide the refinery from Allied bombardiers. As a consequence, only 2.2 percent of all bombs dropped on Leuna actually hit the refinery's production area. The Allies had to strike Leuna 22 times during the last year of the war to put it out of commission. As the US Strategic Bombing Survey concluded, dropping a few bombs accurately would have been far more effective than "string[ing] 500-lb. bombs over the whole target."[38] Exactly true!

The numbers regarding bomb accuracy changed over time. The Vietnam War saw the first extensive use of precision guided munitions (PGM) during the Linebacker campaigns of 1972; American aircraft were then able to demolish that proverbial "small house"with only 190 tons of bombs carried by 95 aircraft.[39] Desert Storm introduced an improvement in accuracy, combined with stealth technology, that allowed a remarkably low loss rate per sortie (less than .05 percent). Aircraft could thus safely hit more targets in a given time period (i.e., parallel operations were possible). Few people will forget the cockpit videos of laser-guided bombs flying down air vents and into bunker doorways. Only a small percentage of the total tonnage dropped was precision guided, and even these bombs sometimes missed their targets; nonetheless, when coalition aircraft used PGMs in suitable weather, our house now rated only one or two bombs and a single aircraft.[40] This combination of accuracy and stealth meant that aircraft could strike and neutralize targets quickly and safely.

The result of the trend towards "airshaft accuracy" in air war is a denigration in the importance of mass. PGMs provide density—mass per unit volume—which is a more efficient measurement of force. In short, targets are no longer massive, and neither are the aerial weapons used to neutralize them.[41] One could argue that all targets are precision targets—even individual tanks, artillery pieces, or infantrymen. No logical reason exists for wasting bullets or bombs on empty air or dirt. Ideally, every shot fired should find its mark.[42] If this sort of accuracy and continued stealth protection are attainable on a routine basis, the political, economic, and logistics implications are great. One can threaten objectives—and attack them, if necessary—with little collateral damage or civilian casualties, at low cost and low risk since one needs so few aircraft. Accuracy and stealth also permit a vastly reduced supply tail: only a handful of cargo aircraft would have been necessary to supply all the PGMs needed each day during the Gulf War. But this fact may present air commanders with an unusual problem.

Because precision is possible, people will expect it. Air warfare has thus become highly politicized. Air commanders must be extremely careful to minimize civilian casualties and collateral damage. All bombs are becoming political bombs, and air commanders must be aware of this emerging constraint. For example, as a result of US strikes against Iraq during June 1993 in retaliation for an attempted assassination of former president George Bush, some European sources expressed concern because the cruise missiles used were "less than totally reliable." Eight Iraqi civilians were reportedly killed in the 30-missile strike, a number of casualties that some people considered exces-

sive.[43] One can safely assume that the omnipresent eye of the Cable News Network camera will be an integral part of any future military operation. Hundreds of millions of people worldwide will judge the appropriateness ofeverything an air commander does.[44]

This reality must be factored into the decision process because in the future, airmen may have to wage war bloodlessly and delicately. The research in the area of nonlethal weapons is certainly a response to this trend. Although the ideal of bloodless war, sought by military leaders for centuries, has proven to be elusive, the quest continues.[45] Because of its intrinsically precise and discriminate nature (properties that are increasing), airpower may finally produce that coveted grail. At the same time, the evolving world situation indicates that America will become more involved in operations short of war, such as peacekeeping missions or humanitarian relief. The airdrop of food to Muslims in Bosnia is an example of this trend. These "food bomb" operations may become increasingly prevalent as our leaders turn to more peaceful applications of airpower to achieve political objectives.

8. Airpower's Unique Characteristics Require Centralized Control by Airmen

Air warfare cannot be separated into little packets; it knows no boundaries on land and sea other than those imposed by the radius of action of the aircraft; it is a unity and demands unity of command.

—Air Marshal Arthur Tedder

Gen Carl Spaatz once commented in exasperation that soldiers and sailors spoke solemnly about the years of experience that went into training a surface commander, thus making it impossible for outsiders to understand their arcane calling. Yet, they all felt capable of running an air force. That comment, echoed by American airmen for decades, was at the root of their calls for a separate air force.

Many early air theorists believed that airpower would never be able to grow and reach its true potential if it were dominated by surface officers. The use of airpower was so unlike traditional warfare that officers raised in the Army and Navy would have difficulty understanding it. (Obviously, the task was not insurmountable; virtually all the early airmen began their careers as soldiers and sailors.) On a more practical level, the question of who controlled airpower became an administrative one. If the Air Force were subservient to the other services, then those services would determine such things as organization, doctrine, force structure, and manning. The American Army Air Service, for example, was commanded by nonaviators, divided up and attached to individual surface units, told what types of aircraft to procureand what missions to fly with those aircraft, and informed by nonflyers which airmen would be promoted and which would not. To say that airmen believed such a setup stifled their potential would be an understatement. For fundamental bureaucratic reasons, airmen wanted a separate service. At a higher level of abstraction, they also believed that airpower was most effective when commanded by an airman who understood its unique characteristics.

Surface warfare is largely a linear affair defined by terrain and figures on a map. Although the modern battle space has expanded dramatically, ground forces still have a primarily tactical focus and tend to be concerned primarily with an enemy or obstacles to their immediate front. Certainly, ground commanders worry about events beyond their immediate reach, but when operations move at an average of a few miles each day, such concerns are long term. New weapons have extended the range that armies can strike and have subsequently expanded their area of concern; nonetheless, this extension is slight, relative to airpower. An airplane can deliver several tons of ordnance in a few minutes at a distance of hundreds of miles, and this ability requires that one think in operational- and strategic-level terms.

Airmen must take a broader view of war because the weapons they command have effects at broader levels of war. Space-based assets, as well as airborne systems such as airborne warning and control system (AWACS) and joint surveillance target attack radar system (JSTARS), help provide a theater-wide perspective. Moreover, Desert Storm was truly a global air war—the first of its kind—with personnel all over the world playing direct roles. For example, space operators in Cheyenne Mountain, Colorado, detected and tracked Iraqi Scud launches and then relayed that information to Patriot batteries in Saudi Arabia. Similarly, B-52s launched from air bases in Louisiana flew nonstop to bomb targets in Iraq. Finally, airlifters flew dozens of missions each day from the United States to the Middle East to deliver supplies and personnel.

Airmen fear that if surface commanders controlled airpower, they would divide it to support their own operations to the detriment of the overall theater campaign. However, in a typical campaign, operations ebb and flow; at times one sector is heavily engaged or maneuvering, while at other times it is static and quiescent—and this status is often determined by the enemy. As a result, if airpower is parceled out, it may be sitting idle in one location while flying continuously

in another. Although this is also true of ground units, they generally have only a limited ability to assist their comrades on another part of the front. Airpower can quickly intervene over an entire theater, regardless of whether it is used for strategic or tactical purposes. To meteit out to different surface commanders would make virtually impossible the rapid and efficient shifting of airpower from one area in the theater to another to maximize its effectiveness.

To airmen, the necessity of centralized control has been amply demonstrated. Since World War I, one has witnessed an inexorable move towards greater centralized control of airpower as aircraft have achieved greater range and firepower. Initially, all air forces were controlled by tactical surface commanders; today, virtually all of the world's air forces are independent. Several examples illustrate this trend. In the North African campaign of 1942, the RAF was divided into packages and controlled by ground commanders. The results were disastrous and led to fundamental doctrinal changes.[46] On the other hand, the air campaigns of Gen George Kenney in the Southwest Pacific and those of Gen Hoyt Vandenberg in Europe demonstrated an extremely effective use of air assets at the theater level. Korea was another negative example, with Air Force and Navy air assets fighting separate wars with little coordination. Vietnam saw this situation repeated—although the Air Force itself violated the principle of centralized control of air assets. Due to struggles within the service, Seventh Air Force in South Vietnam fought the air war in-country, Thirteenth Air Force directed air operations in Thailand, and Strategic Air Command fought yet another campaign with its B-52 strikes.

In Desert Storm, things finally came together. Gen H. Norman Schwarzkopf selected Gen Charles Horner to be his joint force air component commander (JFACC). As JFACC, Horner controlled all fixed-wing assets in-theater, including those of other coalition countries. The synergies gained from diverse air forces working together as a team with one commander to focus their efforts played a major role in victory. During this combat test, the JFACC concept worked; for that reason, it will be the organizational option of choice in the future. This is especially important because future conflicts may not have the overwhelming air assets available that were present in Desert Storm. In such instances, tough decisions regarding prioritization will have to be made by people who understand airpower.

9. Technology and Airpower Are Integrally and Synergistically Related

Science is in the saddle. Science is the dictator, whether we like it or not. Science runs ahead of both politics and military affairs. Science evolves new conditions to which institutions must be adapted. Let us keep our science dry.

—Gen Carl M. Spaatz

A recent US Army pamphlet states that people—not technology—have always been and will always be the dominant force in war: "War is a matter of heart and will first; weaponry and technology second."[47] The centrality of the infantryman and his rifle is a recurring theme in the Army's culture. Because this vision depreciates the importance of technology, most airmen do not subscribe to it.

Airpower is the result of technology. People have been able to fight with their hands or simple implements and sail on water using wind or muscle power for millennia, but flight required advanced technology. As a consequence of this immutable fact, airpower has enjoyed a synergistic relationship with technology not

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common to surface forces, and this is part of the airman's culture.[48] Airpower depends upon the most advanced developments in aerodynamics, electronics, metallurgy, and computer technology. When one considers the space aspects of airpower, this reliance on technology becomes even more obvious. One has only to look at how land warfare has advanced this century; the evolution of machine guns, tanks, and artillery has proceeded at a fairly steady pace. Certainly, that pace has been more rapid than in any other comparable time period, but it pales in comparison to the advance in airpower from Kitty Hawk to the space shuttle.

More importantly, the United States has achieved a formidable dominance in this area. We Americans have a tendency to adopt technological solutions to problems, evidenced in our approach to war.[49] Consequently, we have developed the most technologically advanced military in the world. With some exceptions, our equipment in all branches is unmatched. Indeed, in some areas, our dominance is so profound that few countries even choose to compete with us, and this superiority is especially true in airpower. Iraq simply refused the challenge; it seldom rose to contest coalition fighters, and after two weeks, its planes began fleeing to Iran to escape destruction. Similarly, only the former Soviet Union was able to approach us in the size of strategic airlift and in-flight refueling forces, and those capabilities have rapidly atrophied after the empire's dissolution.

The size and sophistication of American airpower relative to the rest of the world is, at present, staggering. A recent RAND study found that the US has more F-15s in its inventory than the rest of the world (excluding our allies and the former Soviet Union) has front-line combat aircraft combined. Considering that air forces require a level of technology and economic investment that only the richest or most advanced nations can afford, we can expect this favorable balance to continue.[50] Finally, no country can duplicate American space infrastructure, which has sorevolutionized reconnaissance, surveillance, and communications functions. Today, only the United States can project power globally, and that is a fact of enormous significance.

Surprises always occur, but this technological edge is not likely to change significantly over the next few decades. Although the US defense budget is severely shrinking in the aftermath of the cold war, that of Russia has been slashed far more, totaling barely one-sixth that of the US.[51] Similarly, when one considers the aeronautical research and development (R&D) base, the United States has more than twice as many wind tunnels, jet and rocket-engine test facilities, space chambers, and ballistic ranges than the rest of the world combined; at the same time, it is able to maintain a qualitative edge. One must note, however, that this superiority is shrinking as countries in Europe and Asia are accelerating their own aerospace industries. We must guard against complacency.[52]

Some people argue that warfare is presently experiencing a military-technical revolution (MTR), and that this is the third such MTR in history. The first was the invention of gunpowder, and the second the explosion of the late nineteenth and early twentieth centuries, which resulted in the railroad, machine gun, aircraft, and submarine. John Warden goes farther, acknowledging the existence of the present MTR but arguing that it is actually the first such event.[53] He maintains that the current leap in technology is so profound that it makes prior changes appear as minor evolutionary steps. Regardless of whether this MTR is the first or third, airpower is the most affected asset because advancing technologies in space, computers, electronics, low-observable weapons, and information systems will enhance those services that rely on technology to decide the issue of war.

10. Airpower Includes Not Only Military Assets, but Aerospace Industry and Commercial Aviation

With us air people, the future of our nation is indissolubly bound up in the development of airpower.

—Gen Billy Mitchell

A collection of airplanes does not equal airpower, a fact realized by almost all theorists. As early as 1921, Mitchell wrote about the importance of a strong civil aviation industry, the role of government in building that industry, and the importance of instilling an "airmindedness" in the people.[54] His later writings made these points even more emphatically. Similar sentiments were echoed by de Seversky and, most recently, by air leaders who spokeof the United States—the inventor of the airplane—as an "aerospace nation."[55] The vast size of the United States and the need to connect the east and west coasts—indeed, Alaska and Hawaii—demanded a rapid, reliable, and cost-effective method of transportation. The development of various airline companies—still the largest and most financially powerful in the world—was a direct result of American geography and the need it engendered.

Recognizing such economic and cultural imperatives, men like Mitchell and de Seversky stressed that airpower was far more than just airplanes. As discussed above, the technology required to develop first-rate

military aircraft was so enormous, complex, and expensive, it was essential that government and business play active roles. In the early years, this involvement equated to government subsidy of airports, airway structures, location beacons, weather stations, and support for R&D. The investment required for this new industrial field was simply too great for businesses to handle on their own.

Many theorists also assumed that military and commercial aircraft would have similar characteristics and thus would enjoy a symbiotic design relationship. Douhet and de Seversky, for example, noted the feasibility of converting civilian airliners into military bombers or cargo aircraft.[56] More importantly, the skills needed to build, maintain, and pilot these aircraft were also similar. Theorists saw a close relationship developing in aviation that would produce a pool of trained personnel who passed back and forth between the military and civilian sectors—mechanics, pilots, navigators, air traffic controllers, and so forth. In essence, an interdependence existed between the two sectors that was not present in armies or even navies. The capability of an armored force, for example, did not rely on the automobile industry or the teamsters union to the same degree an air force was dependent on the aircraft industry and airline pilots associations.

More importantly, the quality of this aerospace complex is crucial. If transportation is indeed the essence of civilization, then aviation is the one industry in which America must remain dominant. The United States has often been in the forefront of emerging technologies—railroads, shipbuilding, automobiles, electronics, and computers—only to later retreat from the field, leaving it to competitors. We cannot afford to do that in the air and space. Although the current status is favorable, we must avoid negative trends.

Aerospace industry sales topped $140 billion in 1991. The world's airlines overwhelmingly fly American airframes. Although the European Airbus has been able to maintain a world market share of about 15–20 percent in the large commercial jet category, theremaining 80 percent belongs to Boeing and Douglas. Moreover, the new Boeing 777, which has not yet flown, has already garnered nearly 150 orders from airlines worldwide (coincidentally, 80 percent of the market).[57] Internally, this dominance means the aerospace industry has a percentage value of the US gross national product behind only agriculture and automobiles. Consequently, aerospace has a trade surplus of over $30 billion in 1991, ahead of the traditional leader—agriculture—by a wide margin. At the same time, the number of air passengers continues to rise, as does the value and weight of air cargo. In addition, approximately 1 million people are employed in the American aerospace industry, making it the 10th largest in the country.[58] All this progress comes at a time when railroads are in decline and when our commercial shipbuilding industry has all but disappeared.

These figures translate into an extremely powerful and lucrative aerospace industry dominated by the United States. As already noted, the superiority of American military air and space assets is even more profound than in the commercial sector. No country in the world can rival us in the size, capability, diversity, and quality of our air and space forces.[59] Unfortunately, this dominance may be in danger as a result of massive downsizing after our victory in the cold war. One source states that the US is falling behind Europe and Japan in the race to maintain primacy in satellite communications. One must take pains to remember that American dominance in air and space is not automatic but must be constantly reasserted.[60]

Finally, the theorists urged that Americans think of themselves as an airpower nation in the way generations of Englishmen had considered themselves a maritime nation. They must see their destiny in the air and in the space. To a great degree, this perception may already be in place. It is perhaps not just the allure of special effects that has made movies like *Star Trek, Star Wars, The Right Stuff, Top Gun,* and others of that genre so popular in America.[61] In a very real sense, airpower is a state of mind.

These, then, are my 10 propositions regarding airpower. Most have an "ancient" pedigree: Douhet, Mitchell, Trenchard, and others from aviation's earliest years understood and articulated them. Others were mere prophecies and needed a trial in war to determine their veracity. In some cases, such as the proposition regarding the link between targeting and intelligence and the one dealing with centralized control, they had to be tried and tested in several wars before they were understood. Other propositions, such as the one regarding the importance of precision, are just beginning to show their significance and await future conflicts to prove their correctness beyond doubt.

Nonetheless, these propositions in their totality show airpower to be a revolutionary force that has transformed war in less than a century. The fundamental nature of war—how it is fought, where it is fought, and by whom it is fought—has been altered. An unfortunate characteristic of air theorists is that they long promised more than their chosen instrument could deliver. Theory outran technology, and airmen too often were in the untenable position of trying to schedule inventions to fulfill their predictions.[62] It appears that those days are now past. Airpower has passed through its

childhood and adolescence, and the wars of the past decade—especially in the Persian Gulf—have shown it has now reached maturity.

Notes

l. Svi Lanir, "The `Principles of War' and Military Thinking," *Journal of Strategic Studies* 16 (March 1993): 1–17.

2. Renato D'Orlando, trans., *The Origin of Air Warfare* 2d ed. (Rome: Historical Office of the Italian Air Force, 1961), passim.

3. Giulio Douhet, *The Command of the Air,* trans. Dino Ferrari (1942; reprint, Washington, D.C.: Office of Air Force History, 1983), 25.

4. Col John A. Warden III, *The Air Campaign: Planning for Combat* (New York: Pergamon-Brassey's, 1989), 10. He later implies that this statement may not necessarily be true in low-intensity conflict.

5. This does not apply, of course, to the new threat of ballistic missiles. Iraqi Scuds were a major menace in the Gulf War, and this threat will no doubt continue to grow in the years ahead.

6. The classic work on the evolution of the aircraft carrier and naval air doctrine is Clark G. Reynolds's, *The Fast Carriers: Forging an Air Navy* (New York: McGraw-Hill, 1968).

7. Martin Blumenson, "A Deaf Ear to Clausewitz: Allied Operational Objectives in World War II," *Parameters* 23, no. 2 (Summer 1993): 16. Napoléon commented that European generals saw too many things, whereas he saw only one thing—the enemy army.

8. For a grimly pessimistic view regarding the inherently indecisive nature of land warfare, in any age, see Russell Weigley, *The Age of Battles: The Quest for Decisive Warfare from Breitenfeld to Waterloo* (Bloomington, Ind.: Indiana University Press, 1991).

9. Mancur Olson, Jr., in *The Economics of the Wartime Shortages: A History of British Food Supplies in the Napoleonic War and in World War I and World War II* (Durham, N.C.: DukeUniversity Press, 1963), argues that Napoleonic and later German attempts in two world wars to starve Britain into submission were failures and never came close to success. On the other hand, naval embargoes can cause great hardship if imposed for a long period of time, as against Iraq since August 1990. Youssef M. Ibrahim, "Iraq Is Near Economic Ruin but Hussein Appears Secure," *New York Times,* 25 October 1994, 1.

10. For the airpower advocates, see Adm U. S. G. Sharp, *Strategy for Defeat: Vietnam in Retrospect* (San Rafael, Calif.: Presidio Press, 1978); and Gen William Momyer, *Airpower in Three Wars* (Washington, D.C.: Government Printing Office, 1978). For the opposing view, see Maj Mark Clodfelter, *The Limits of Air Power: The American Bombing of North Vietnam* (New York: Free Press, 1989).

11. Sun-Tzu, *The Art of War,* trans. Roger T. Ames (New York: Ballantine Books, 1993), 115.

12. H. G. Wells, *The War in the Air* (London: George Bell, 1908), 247–48.

13. A typical example used by early airmen was the London air defenses of 1918, which included over 600 aircraft to counter a German bomber force of approximately 40 planes. Squadron Ldr J. C. Slessor, "The Development of the Royal Air Force," *RUSI* (Royal United Services Institute for Defense Studies) *Journal* 76 (May 1931): 328.

l4. This is an interesting instance of airpower's unique strength also being a weakness: aircraft generally "get through" because aircraft on the defensive lack "stopping power." Precisely because ground defenders can dig in and hold their position, they can repel an attack; aircraft cannot.

15. The Battle of Britain remains the major notable exception. Partial victories for the defense might include the retreat to night operations by Royal Air Force (RAF) Bomber Command to escape German defenses and the temporary lull in American bombing operations in fall 1943 after severe losses in daylight strikes.

16. The most notable exception to this principle occurred during the Battle of Britain, when the RAF withheld a large portion of its forces from the air battle. However, the RAF did not withhold for the traditional reasons of reserve employment or to exploit or plug, but to husband scarce resources of men and planes. Had the RAF been equal to the Luftwaffe in numbers and had it possessed a ready supply of reinforcements, it would have gained little by holding back its forces. For a contrary view on the desirability of an air reserve, see Warden, 115–27.

17. As one airman put it, one should consider an air reserve while the battle for air superiority is still raging; afterachieving air superiority, the need for a reserve loses its rationale. Group Capt Gary Waters, Royal Australian Air Force (RAAF), to the author, letter, subject: Air Reserves, 26 July 1993.

18. Douhet, 50.

19. Maj Gen Don Wilson, "Origins of a Theory of Air Strategy," *Aerospace Historian* 18 (Spring 1971): 19–25.

20. One should not take Slessor out of context. *Air Power and Armies* was a collection of lectures he presented while an instructor at the British Army Staff College in the early 1930s. Given his audience, he was forced to address airpower in the context of a land campaign. Nonetheless, he reminded his readers that the primary role of airpower was to conduct strategic bombing operations against an enemy's centers of gravity. Wing Comdr John C. Slessor, *Air Power and Armies* (London: Oxford University Press, 1936), 3.

21. Col John A. Warden III, "Employing Air Power in the Twenty-first Century," in Richard H. Shultz, Jr., and Robert L. Pfaltzgraff, Jr., eds., *The Future of Air Power in the Aftermath of the Gulf War* (Maxwell AFB, Ala.: Air University Press, July 1992), 65.

22. Brig Gen William L. Mitchell, *Our Air Force: The Keystone of National Defense* (New York: Dutton, 1921), 15.

23. Interestingly, not only have most air theorists had a single, key target theory, but they have also been surprisingly prescriptive: their target is the key in all types of wars, in all types of situations, and against all types of opponents.

24. David Albright and Mark Hibbs, "Iraq's Bomb:

Blueprints and Artifacts," *Bulletin of the Atomic Scientists,* January–February 1992, 30–40.

25. For an overview of the origins of this subject, see Robert F. Futrell, "U.S. Army Air Forces Intelligence in the Second World War," in Horst Boog, ed., *The Conduct of the Air War in the Second World War* (New York: Berg, 1992), 527–52.

26. John Arquilla and David Ronfeldt, "Cyberwar Is Coming!" *Comparative Strategy* 12 (April–June 1993): 143. In this interesting article, the authors argue that "netwar" and "cyberwar"—the attack on a country's information and communications systems—will be the dominant features of future wars.

27. I observed this example when I worked on the Air Staff in the Pentagon during the Gulf War. For an excellent critique of BDA in the Gulf War, see Lt Col Kevin W. Smith, *Cockpit Video: A Low-Cost BDA Source,* Research Report no. AU-ARI-93-1 (Maxwell AFB, Ala.: Air University Press, December 1993).

28. Gulf War Air Power Survey, *Effects and EffectivenessReport,* vol. 2 (Washington, D.C.: Government Printing Office, 1993), 303.

29. Lt Col Jason Barlow, a former student at the School of Advanced Airpower Studies, suggested this subject to me. His seminal master's thesis, *Strategic Paralysis: An Airpower Theory for the Present* (Maxwell AFB, Ala.: Air University Press, February 1994), first raised my consciousness to the symbiotic relationship between centers of gravity and the best ways of affecting that relationship.

30. Robert L. Helmhold, *Rates of Advance in Historical Land Operations* (Bethesda, Md.: US Army Concepts and Analysis Agency, June 1990), 1–9.

31. John Boyd has remained a somewhat legendary figure among a small coterie of American military officers. He has never published his theories but relies on lengthy briefings that include dozens, if not hundreds, of slides. For a good discussion, see Maj David S. Fadok, *John Boyd and John Warden: Air Power's Quest for Strategic Paralysis* (Maxwell AFB, Ala.: Air University Press, February 1995).

32. For an excellent discussion, see Col Dennis M. Drew, *Insurgency and Counterinsurgency: American Military Dilemmas and Doctrinal Proposals,* CADRE Paper no. AU-ARI-CP-88-1 (Maxwell AFB, Ala.: Air University Press, March 1988), 39–40.

33. J. F. C. Fuller, *The Reformation of War* (New York: Dutton, 1923), 48–50.

34. At the Third Battle of Ypres (1917), the preliminary British artillery bombardment consisted of 4,283,550 shells, costing $110 million, weighing 107,000 tons, and requiring 35,666 truckloads to transport them from the railhead to the battlefield. Maj Gen J. F. C. Fuller, *Machine Warfare* (Washington, D.C.: *Infantry Journal* Press, 1943), 17.

35. F. W. Lanchester, *Aircraft in Warfare: The Dawn of the Fourth Arm* (London: Constable, 1916), 39–65.

36. James Parton, *"Air Force Spoken Here": General Ira Eaker and the Command of the Air (New York: Adler & Adler, 1986), 290.*

37. Gen Michael Dugan, "The Air War," U.S.News & World Report, 11 February 1991, 27.

38. US Strategic Bombing Survey, "Oil Division: Leuna," report no. 115, 1946, 51.

39. Dugan, 27.

40. Ibid.; and Richard P. Hallion, *Storm over Iraq: Air Power and the Gulf War* (Washington, D.C.: Smithsonian Institution Press, 1992), 303–7. The potential downside of this situation is that one terrorist with a satchel charge could not have eliminated 4,500 bombers, as is presently the danger with a single aircraft.

41. One should note that stealthy effects can also be generated by speed (e.g., a ballistic missile with 15-meter accuracy, such as the Soviet SS-21). Such missiles are, of course, limited by their expense and nonreusable nature.

42. An alternative view: the psychological effect of bombing is so devastating that even a miss can have a great impact. Take for example the story of the Iraqi troop commander who, when asked why he surrendered, replied that he did so because of the B-52 strikes. When someone pointed out that his division had never been attacked by B-52s, he responded that that was true, but he had seen a division that had been hit by B-52s. Hallion, 218.

43. Francis Tusa and Glenn W. Goodman, Jr., "Who Benefits from Baghdad Bashing?" *Armed Forces Journal International* 131, no. 1 (August 1993): 10. One should also note that countermeasures to at least some types of precision weapons may exist. Miniature jammers that reportedly can disrupt the signals of global positioning system (GPS) guidance systems have been developed and would be easy to mass-produce. John G. Ross, "A Pair of Achilles Heels," *Armed Forces Journal Intemational,* November 1994, 21–23.

44. For an excellent discussion of this issue, see Lt Col Marc Felman, *The Military/Media Clash and the New Pnnciple of War: Media Spin* (Maxwell AFB, Ala.: Air University Press, June 1993). In addition, the US Army's new doctrine manual emphasizes the importance of the media in shaping military operations. Field Manual (FM) 100-5, *Operations,* June 1993, 3–11.

45. Lt Col Alan W. Debban, "Disabling Systems: War-Fighting Option for the Future," *Airpower Journal* 7, no. 1 (Spring 1993): 44–50; Mary C. Fitzgerald, "The Russian Image of Future War," *Comparative Strategy* 13 (Summer 1994): 167–80. On the other hand, one study argues that the American public has more often called for stern action against an enemy when casualties mount. Thus, an enemy who tries to shed American blood in the hope it will break public will has generally provoked the opposite response. Benjamin C. Schwarz, "The Influence of Public Opinion Regarding Casualties on American Military Intervention: Implications for U.S. Regional Deterrence Strategies," draft, RAND, Santa Monica, Calif., 1993.

46. Vincent Orange, *Coningham* (London: Methuen, 1990), 132–37.

47. Gen Gordon R. Sullivan and Lt Col James M. Dubik, *Land Warfare in the 21st Century* (Carlisle Barracks, Pa.: Strategic Studies Institute, February 1993), 27.

48. To illustrate, when one visits an Air Force museum, the emphasis is on aircraft and weaponry displays; at an Army museum, the focus is on people, uniforms, and personal ar-

mament and equipment. For an excellent discussion of these culturaldifferences, see Carl H. Builder, *The Masks of War: American Military Styles in Strategy and Analysis* (Baltimore: Johns Hopkins University Press, 1989).

49. Russell Weigley, in *The American Way of War* (New York: Macmillan, 1973), advances this thesis most strongly.

50. Christopher J. Bowie et al., *Trends in the Global Balance of Airpower,* RAND Report MR-478/l-AF (Santa Monica, Calif.: RAND, 1995), 2, 49. This fact is especially compelling when one notes that the F-15 is 95-0 in air-to-air combat engagements.

51. In 1992 the US defense budget was $242.7 billion; Russia's total that year was $39.6 billion. Other major countries and their defense budgets (in billions of dollars) in 1992: China—$22.3, France—$21.8, United Kingdom—$20.7, Germany—$19.2, Japan—$16.9, Saudi Arabia—$14.5, Italy—$10.6, and Kuwait—$10.1. (All figures in 1985 dollars, using International Monetary Fund [IMF] exchange rates.) International Institute for Strategic Studies, *The Military Balance, 1993–1994* (London: Brassey's, 1993), 224.

52. "An Aerospace Challenge and the Path toward a New Horizon," Arnold Engineering Development Center paper and briefing, June 1993.

53. Col John A. Warden III, to Paul Wolfowitz, letter, subject: Comments on Study by Col Andy Krepinevich ("The Military-Technical Revolution" [Washington, D.C.: Office of the Secretary of Defense, August 1992]), ca. September 1992.

54. Mitchell, 143–58, 199–216.

55. Alexander P. de Seversky, *Victory through Air Power* (New York: Simon & Schuster, 1942), 329; and Donald B. Rice, *The Air Force and U.S. National Security: Global Reach—Global Power* (Washington, D.C.: Department of the Air Force, June 1990), 15.

56. Douhet, 124; and de Seversky, 296.

57. Harvey Elliot, "America Takes Over the Skies," *London Times*, 10 January 1994, 21.

58. All of these statistics come from James W. Chung, "Whither the U.S. Aerospace Industry?" *Breakthroughs*, Winter 1992–1993, 12–18.

59. The emerging dominance of airpower within American military strategy is covered in Col Dennis M. Drew, "We Are an Aerospace Nation," *Air Force*, November 1990, 32–36.

60. "Panel Says U.S. Losing Race for Next Generation Satellite Communications," *Aerospace Daily*, 30 July 1993, 168–69. For a good discussion, see Maj Steven Wright, *Aerospace Strategy for the Aerospace Nation* (Maxwell AFB, Ala.: Air University Press, August 1994).

61. For an excellent overview of the connection between aviation and American culture, see Robert Wohl, "Republic of theAir," *Wilson Quarterly* 17 (Spring 1993): 107–17.

62.Precisely the opposite may be said of military space operations, whose technology has far outpaced any coherent doctrine on how to employ space systems effectively.

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